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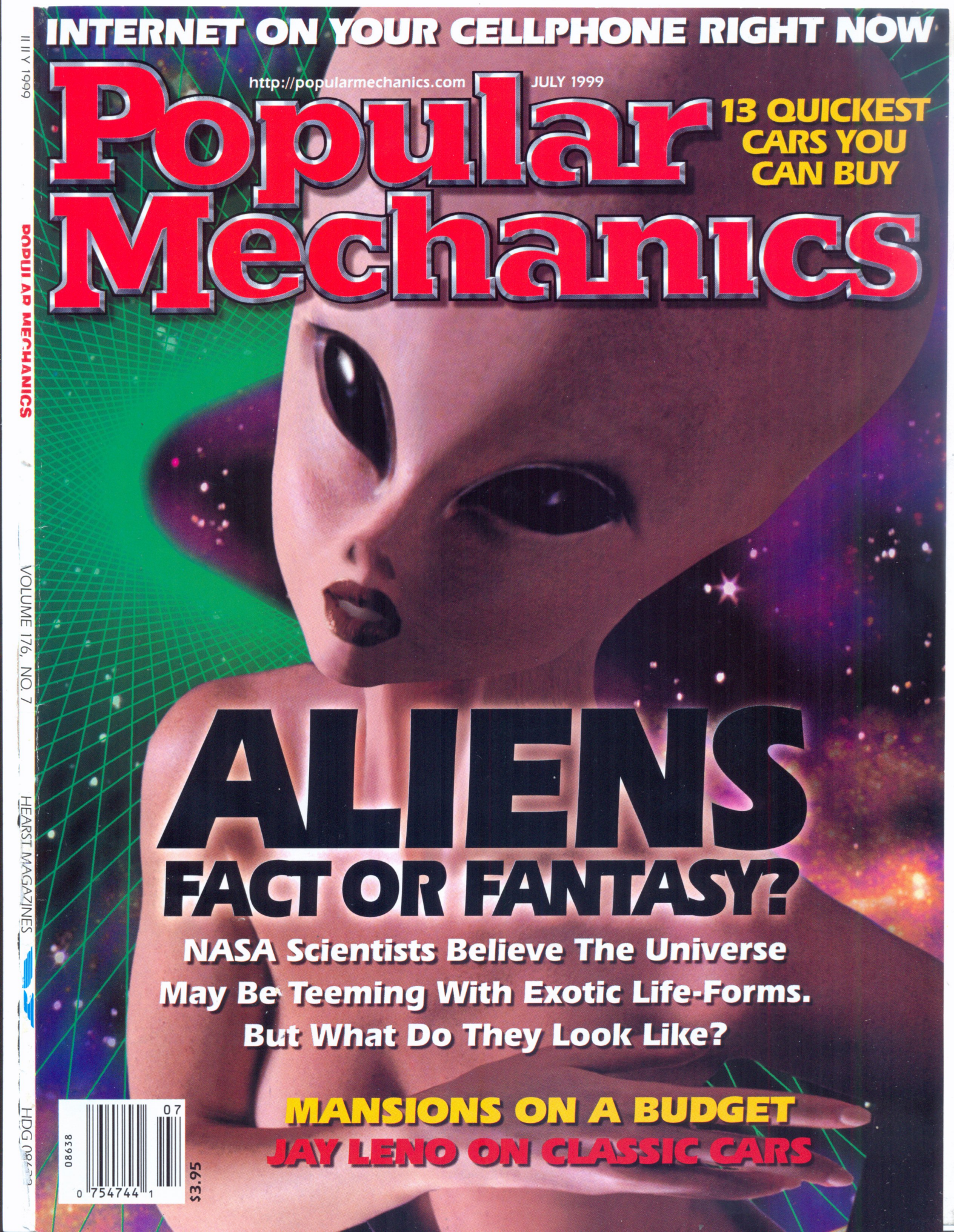

ALIENS
FACT OR FANTASY?

NASA Scientists Believe The Universe May Be Teeming With Exotic Life-Forms. But What Do They Look Like?

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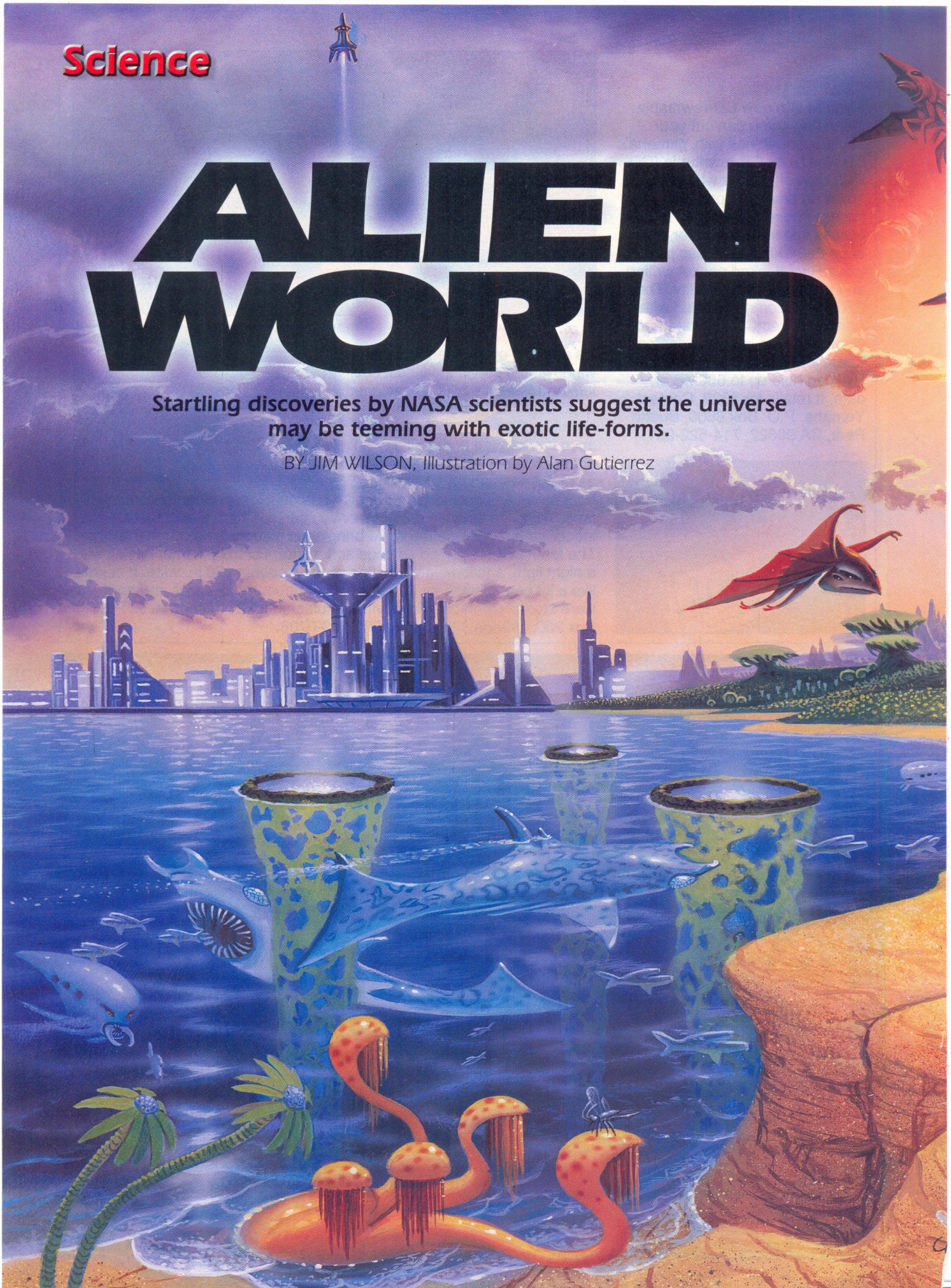
Science

ALIEN WORLD

Startling discoveries by NASA scientists suggest the universe may be teeming with exotic life-forms.

BY JIM WILSON, Illustration by Alan Gutierrez



If the case for extraterrestrial life were

put to a jury it probably would be out for less than 5 minutes before returning the verdict that we are not alone. No one expects E.T. to come knocking on the door of 1600 Pennsylvania Ave. However, recent research findings, including the discovery of the first solar system other than our own, have convinced leading scientists that life probably exists on the surfaces and in the oceans of distant planets and their moons, and perhaps even in the void of space itself.

More than simply convincing skeptical scientists, these recent findings have quietly moved NASA to abandon its long-standing position that biologists need not apply. Now, NASA is welcoming microbe hunters with open arms. One indication of its enthusiasm came in a surprise announcement by NASA administrator Daniel Goldin. Speaking to more than 1000 aerospace executives and senior military officers who gathered for the 15th annual Space Symposium in Colorado Springs, Colo., Goldin said he would order all NASA employees to take

As scientists begin to ponder data that show the ingredients of life to be plentiful in the universe, they have begun to speculate how subtle change in factors such as gravity and sunlight might influence the development of alien life-forms. In this artist's conception of an alien world, a stronger gravitational field has produced a higher-density atmosphere. Creatures can fly using smaller wings than would work on Earth. But less light reaches the planet's surface. The "trees" have responded by concentrating their "leaves" near their tops where each will receive maximum exposure to sunlight.

BIODIVERSITY OF FLIGHT

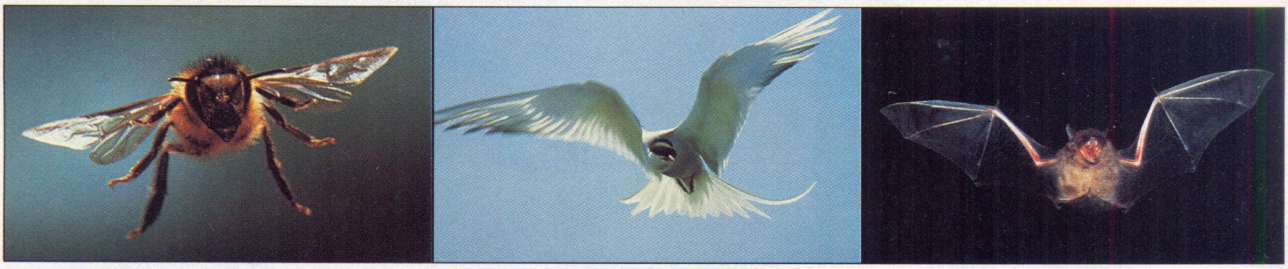


PHOTO (LEFT) BY ANIMALS ANIMALS/STEPHEN DALTON; PHOTO (CENTER) BY ANIMALS ANIMALS/NORBERT ROSING; PHOTO (RIGHT) BY ANIMALS ANIMALS/FRED WHITEHEAD

Identical conditions do not lead to identical evolution, as aptly illustrated by the differences in the wings of common bugs, birds and bats.

a basic course in biological science.

The announcement wasn't the agency's first step toward recognizing that life may come in more flavors than those found on Earth. About the time tiny *Pathfinder* was mesmerizing the nation with its robotic exploration of Mars (see "48 Hours In Mission Control," Oct. 1997, page 62), Goldin was ordering the managers of the cash-strapped space agency to find a way to create an Astrobiology Institute (AI). "Its [funding] isn't impressive by National Institutes of Health standards, but it is impressive," says Kenneth Nealson, one of the project's senior scientists. Nealson's presence is yet another indication of NASA's seriousness. In addition to working for the Jet Propulsion Laboratory in Pasadena, Calif., Nealson serves on the National Academy of Sciences' subcommittee for Solar System Exploration.

"The search for life is no longer a fringe type of thing," Nealson tells POPULAR MECHANICS. "We are attracting great people." The top priority for Nealson and his colleagues at the 11 major government and university laboratories that form AI is to answer this question: What does an alien really look like?

What Aliens Eat

The first step in imagining what a real alien might look like is to forget you ever watched the "The X-Files." They won't be the sinister grays Fox Mulder pursues, little green men or even jolly old E.T. And most assuredly they won't look like us.

"Most life on Earth is not even life as we know it," says Sara Via, a professor of biology and entomology at the University of Maryland in College Park. Via was recently asked to enlighten the scientific community on the possible shape of extraterrestrial life at a special conference organized by the American Association for the Advancement of Science (AAAS). The fact that AAAS, an umbrella organization whose members include 282 scientific societies and 143,000 scientists, called a session

Professor Vidali proved that basic chemical processes can take place in near-absolute-zero cold and in spacelike vacuums.

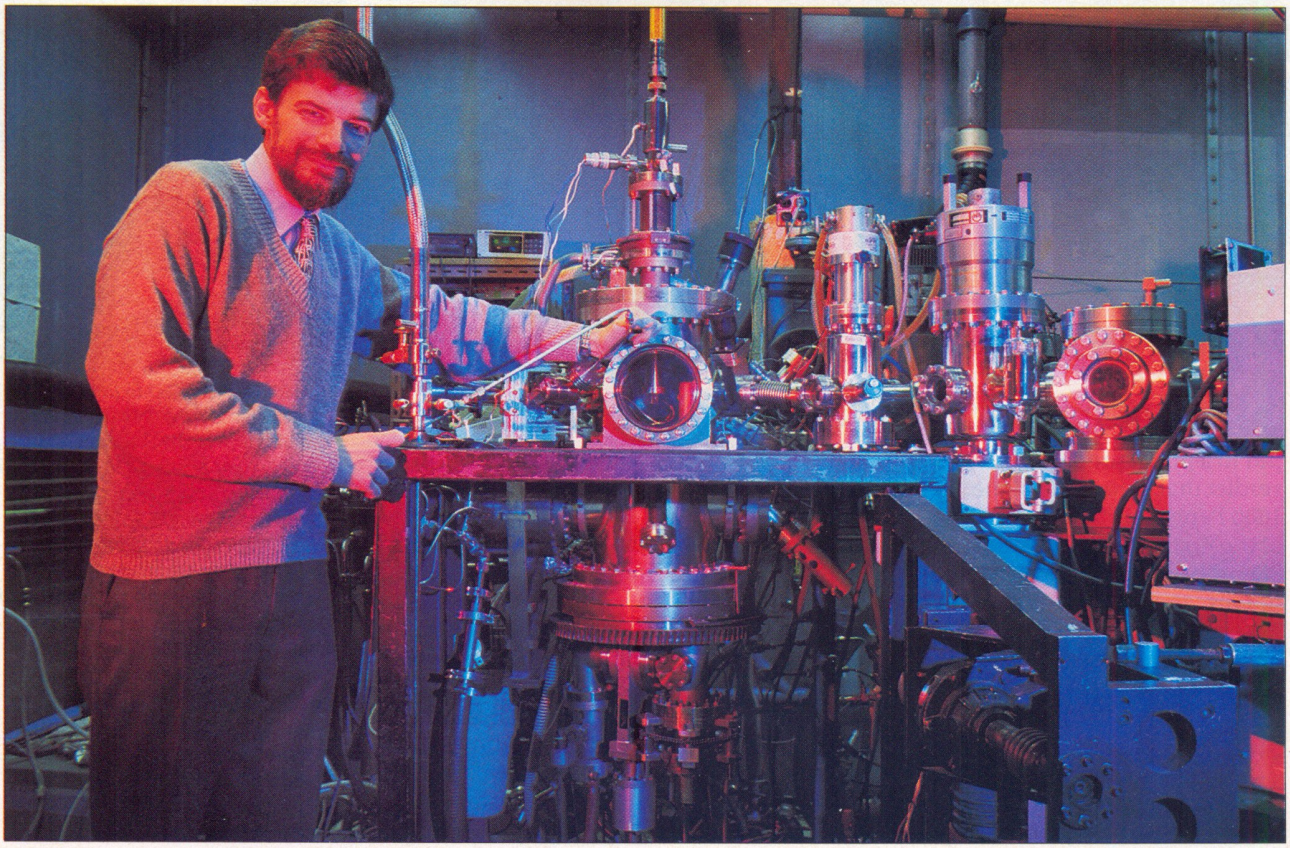


PHOTO BY CLIFF GROMER

"We don't want to run into life and miss it because we asked the wrong questions."

on the possibilities of extraterrestrial life by itself says a lot about the growing legitimacy of astrobiology research. "Human life is a minuscule branch of the tree of life," says Via. "If the Earth was formed at midnight, humans arrived at 11:59:40 pm." While some might look to theology to explain our sudden appearance, Via suggests the fossils. They show that for most of the planet's 4 billion-plus-year existence, Earth has not been an especially pleasant place to visit, let alone live. In fact, the environment was downright poisonous to oxygen-breathing life. "The first cells, which emerged at about 3 am, metabolized hydrogen sulfide," she points out.

The lesson she wants astrobiologists to take from the fossil record is that life "out there" could be far different than even the most imaginative science fiction writers have fancied. In the refrigerator where astronomers who use radio telescopes to search for intelligent life keep their lunches, you will also find a bottle of champagne. If a similar hunt for intelligence is going on elsewhere in the universe, the bubbly may be battery acid.

Not knowing what aliens like to drink, whether they eat or if they even have a mouth, throat or stomach, makes the identification of alien life all the more difficult. "We don't want to run into life and miss it because we asked the wrong questions," says Nealson. To avoid asking the wrong questions, astrobiologists have dramatically changed their ideas about what constitutes life. Explorations by teams probing the ice-covered lakes in the McMurdo Dry Valleys of Antarctica and the depths of the Pacific Ocean have within the past decade literally rewritten the textbooks as far as discussing the life that is here on Earth. And so, today we recognize that life-forms can thrive in conditions as cold as about -5°F and as hot as 240°F, in fluids ranging from distilled water to pickle juice, and in radiation fields that you wouldn't want to roam without a lead suit. And that is just here on Earth. Out there, life could be even more adaptable.

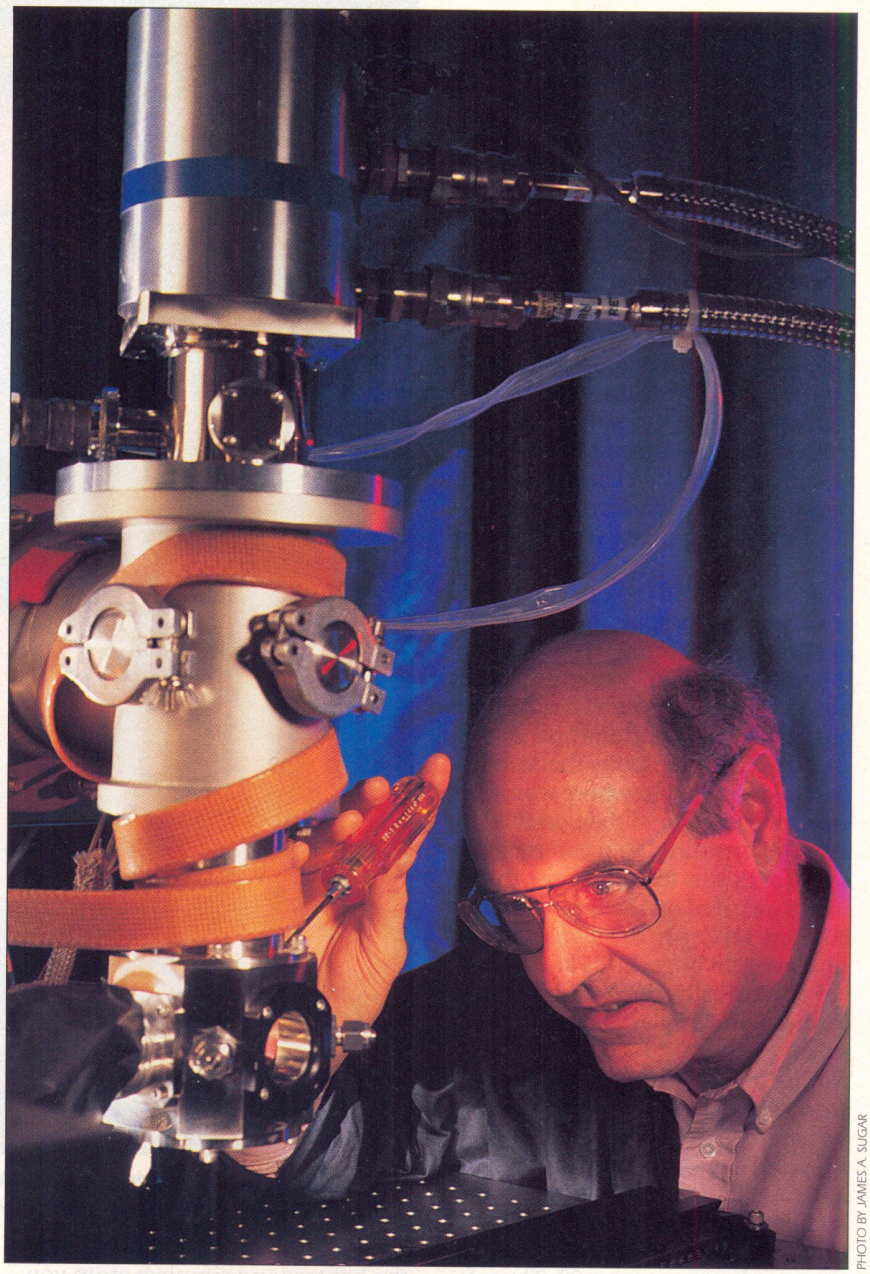


PHOTO BY JAMES A. SUGAR

In his NASA-Ames lab, Allamandola has observed PAHs forming cell-like structures.

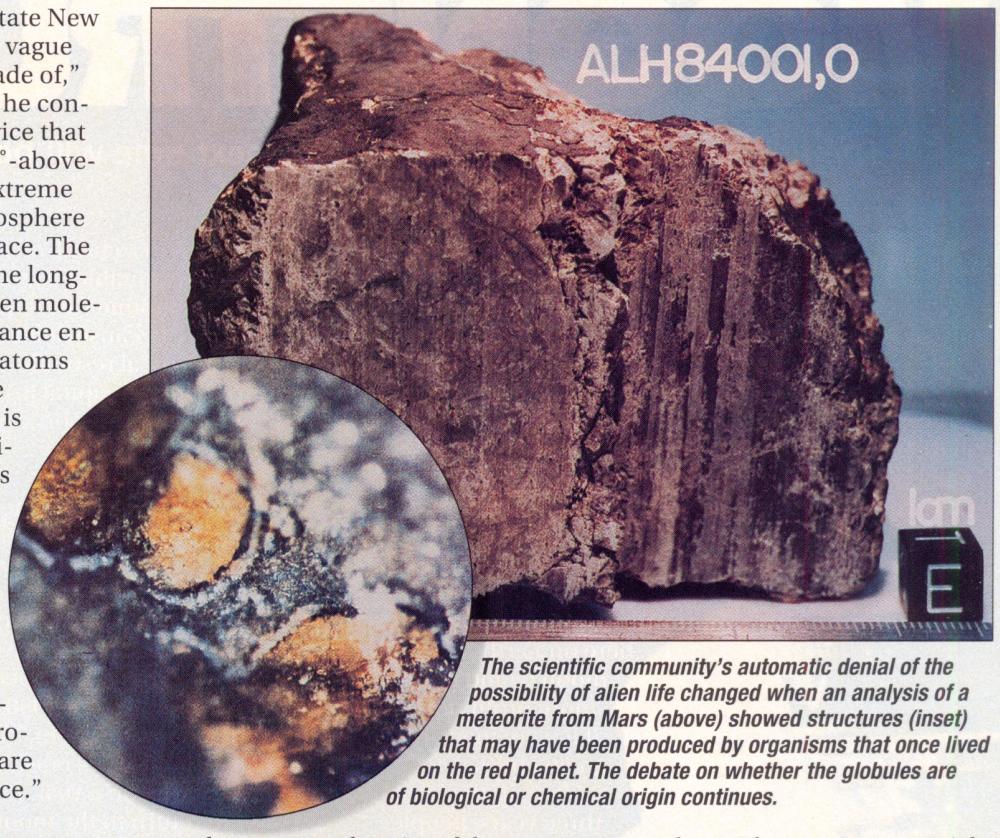
Places To Look

"You can expect to see the announcement of thousands of new planets over the next several years," says David Latham. A research scientist at the Harvard-Smithsonian Astrophysics Center at Harvard University, he is the discoverer of a planet 11 times the size of Jupiter orbiting a yellowish star in the constellation Coma Berenices. Thus far 20 of these extrasolar planets have been indirectly observed and their orbits plotted, based on the wobble of their parent stars (see "Are We A Cosmic Oddball?," May 1999, page 58). "I see no reason why each star shouldn't have a planetary companion," Latham says. Add to this number of planets—which is potentially in the billions of billions—herds of smaller moons that might create niches for life and you begin to get a better idea of the possible range of diversity in the alien world.

All things being equal, a force as subtle as gravity could drastically change the shape of life. If an atmosphere develops on a dense planet, gravitational forces mean that it,

"The finding implies that carbon-based life could be possible throughout the universe."

Vidali's laboratory in upstate New York. "It is only known in vague terms what stardust is made of," he says. To help find out, he constructed an elaborate device that duplicates the intense 10°-above-absolute-zero cold and extreme one-trillionth-of-an-atmosphere vacuum of interstellar space. The experiments confirmed the long-held theory that a hydrogen molecule doesn't form by a chance encounter of two hydrogen atoms in the nearly empty space between stars. "A surface is required to make a chemical reaction happen," says Vidali. "We found that certain materials are better promoters of this reaction than others. These discoveries will help theorists to re-examine the various routes and conditions under which molecular hydrogen and other molecules are formed in interstellar space."



PHOTOS BY NASA

The scientific community's automatic denial of the possibility of alien life changed when an analysis of a meteorite from Mars (above) showed structures (inset) that may have been produced by organisms that once lived on the red planet. The debate on whether the globules are of biological or chemical origin continues.

PAHs To Life

"The finding that organic chemistry is abundant in the universe and that life's essential, prebiotic [nonliving] carbon-based building blocks are abundant in the interstellar medium implies that carbon-based life could be possible through the universe," says Farid Salama of the NASA-Ames Research Center in Mountain View, Calif. "Polycyclic aromatic hydrocarbons (PAHs), a family of carbon-containing compounds that are common on Earth in coal, soot and automobile exhaust, may be the most abundant class of organic molecules in the universe."

These findings have excited the astrobiology community. "If molecules as large and complex as PAHs exist in the diffuse interstellar medium, then current theories of the chemistry of these regions will have to be fundamentally revised," says Theodore P. Snow of the University of Colorado in Boulder. "We know that fundamental new information about the cosmos and about our origins will follow once we can identify the complex molecules whose presence is demonstrated [in space]."

An experiment by Salama's Ames colleague, Louis J. Allamandola, explains how the next critical step—from interstellar chemistry to the chemistry of life—may occur. "The origin of life on Earth is tied to the formation and chemical history of carbon compounds," he says.

In his laboratory, Allamandola exposes ice laced with small quantities of these building blocks to ultraviolet radiation and cosmic rays, then warms them. The process essentially mimics the fate of comets that spend their lives roaming the vastness of space before crashing into moons or planets.

Two things happen. The first is what Allamandola describes as the "ready formation" of a series of complex organic compounds created from simple starting mixtures that are essential to life. The second, and more surprising, development is that some of these organic compounds begin to self-organize. They create membranelike walls around tiny structures that resemble cells. "The ability to trap energy receptors within these structures is considered a critical step in the origin of life as it provides the means to power the protocell," says Allamandola.

If processes similar to those duplicated in the laboratory are in fact happening out there, the universe may well be teeming with primitive and, by implication, even advanced forms of life. Before you dismiss this possibility, consider this: One hundred years ago, the medical community wasn't entirely sold on the disease-causing role of the invisible critters we call bacteria. PM

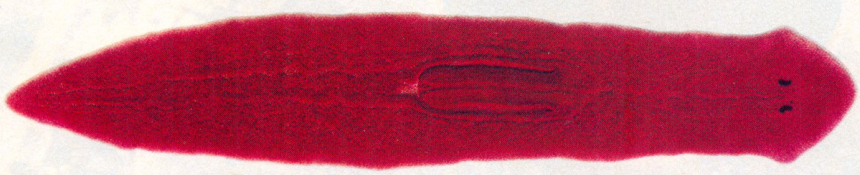


PHOTO BY PHOTOTAKE/CAROLINA BIOLOGICAL SUPP.

Nature evolves by keeping ideas that work. One example we see all around us is bilateral symmetry. First observed in the flatworm, it is the most recognizable feature of humans.

too, is relatively dense. One implication: Creatures that travel through this thicker air could therefore remain aloft or glide on smaller wings.

Given the possibility of so much diversity, astrobiologists are hopeful that nature will have created some universal laws of biology. This idea springs from physics and chemistry. Observations of the movement and light signatures of distant stars have confirmed that the physical and chemical rules that operate here on Earth hold sway throughout the universe. Via suggests that there are also analogous laws of biology. This would likely include a universal imperative that all life-forms evolve. "Evolution—change over time—is a fact," says Via.

If this is indeed the case the discovery of even a spoonful of bacteria in Martian soil would strongly imply that more advanced creatures might have evolved elsewhere, if not on the red planet, most certainly on a distant orb. The possibility that evolution takes place elsewhere would enormously expand the possible range of creatures. You can get a sense of this by looking at the three wings pictured on the top of page 66. Here on Earth, the wing evolved separately in bugs, birds and bats.

Paradoxically, the possibility that evolution takes place elsewhere might simplify the search for life. Nature jealously guards ideas that work. For example, the bilateral symmetry—opposing arms, legs, eyes and ears—that we recognize as a familiar feature of humans and higher animals actually traces its origins to the humble flatworm, like the one shown on page 69. Thus, focusing on the most basic similarities among all living organisms could provide the most important clue to the discovery of alien life.

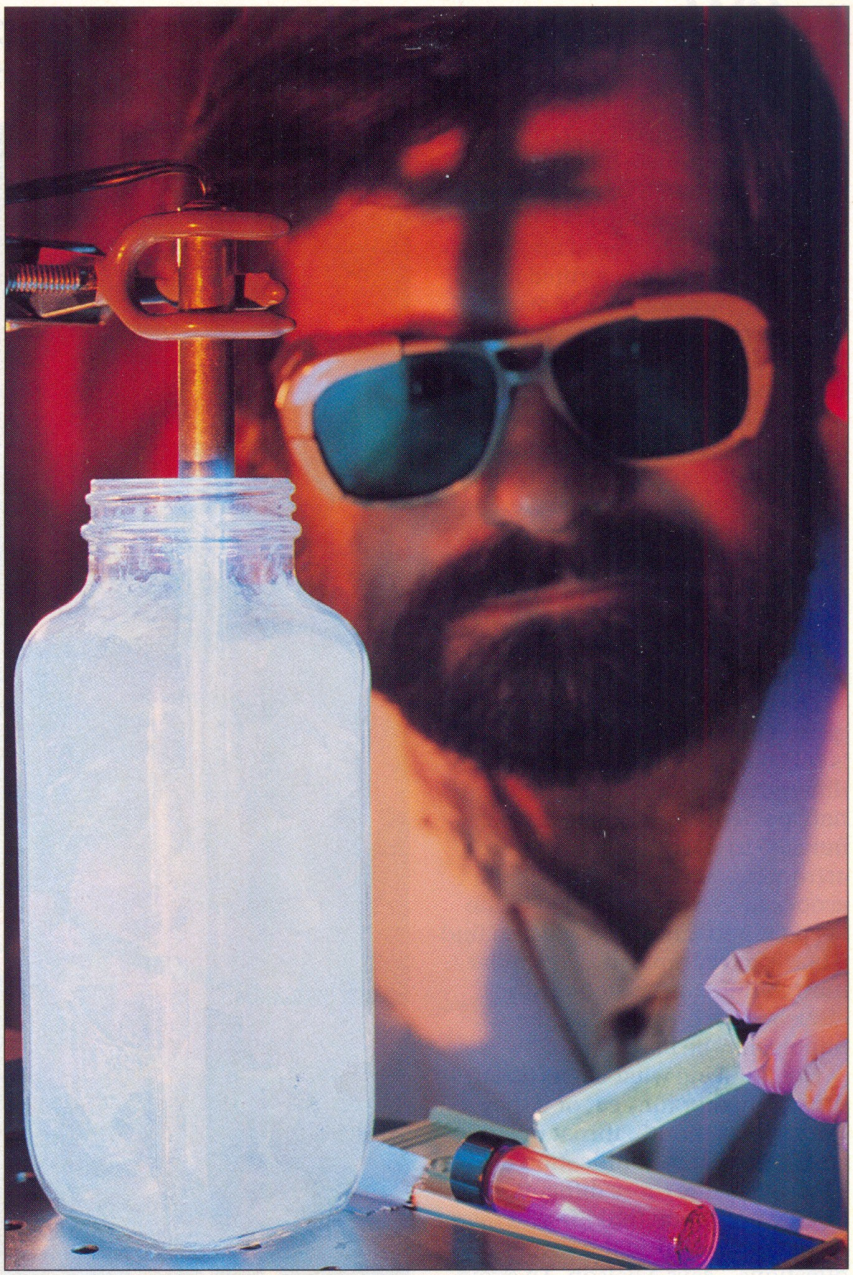


PHOTO BY JAMES A. SUGAR

"PAH compounds are in every breath we take and form the black stuff you're not supposed to eat on hamburgers," says NASA's Douglas M. Hudgins.

Cold Chemistry

Many scientists believe the best way to search for our origins is to begin with the basics. Stripped to its fundamentals, the universe doesn't get any more basic than hydrogen. "It might not seem so for someone living on Earth, but the most abundant element in the universe is hydrogen," says Gianfranco Vidali, professor of physics at Syracuse University. "The hydrogen atom is the lightest and simplest atom you can think of. Put two hydrogen atoms together and you have the lightest, most abundant and simplest molecule."

About 150 years ago, astronomers realized the space between stars was occupied by a thin dispersion of dust particles, smaller than the width of a human hair. "Molecular hydrogen has two main roles in interstellar space," Vidali explains. "First, it helps the formation of stars by carrying away some of the heat that is produced when gas rushes toward the core of a future star. Second, molecular hydrogen helps form other, more complex molecules."

We know that everything that is alive here on Earth is constructed of complex molecules. Given the scientific community's acceptance of the universality of chemical laws, it is safe to assume that the same processes take place everywhere. And so the most basic experiment needed in the quest for alien life is being performed in

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